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MEMORANDUM FOR PRS

FROM: PROI (TI) (STINFO)

19 July 1999

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-FY99-0168**
2 — W. Hoffman, "Carbon-Carbon Protective Tubes"

Other sheet says MacLachlan is author.

(Statement A)

intro re write
– Ranney

High temperature protective tubes for the F-22 fighter's spin chute struts had to be acquired and installed quickly due to changing needs. The solution was found at the Propulsion Directorate, whose carbon-carbon In-Situ Densification process had already demonstrated rapid small-scale densification of high quality components at low cost.

In May 1999, the Directorate's Propulsion Sciences Division was able to produce the needed components in just eight weeks. This time included the scale-up of the carbon-carbon In-Situ process and the facilities to produce components of the required size. Other sources would have taken three to five months to produce similar components.

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Success Story

Carbon-Carbon Protective Tubes

High temperature protective tubes for the F-22 fighter's spin chute struts had to be acquired and installed quickly due to changing needs. A solution was found at the Propulsion Directorate, whose In-Situ Densification process had already demonstrated high speed, low cost densification of high quality carbon-carbon on a smaller scale than needed. In May 1999, Propulsion Sciences Division was able to do in two weeks what would take an existing facility three to five months. The Division scaled up the In-Situ process and produced parts for the qualification testing in just eight weeks, as well as assembling a new facility.

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Accomplishment

The In-Situ Densification Process is an impregnation process that, in contrast to commercial processes, is able to densify a carbon-carbon composite uniformly. This is accomplished by using a low viscosity matrix precursor that has a high carbon yield. With this process there is no need for machining to open up the surface pores and a uniform density results. In addition, because the precursor has a high carbon yield, fewer cycles are needed to bring the composite to the same final density as current processes. The performance of the In-Situ material equals or surpasses that of commercial material in both liquid rocket engines and solid rocket motors. In most applications it is not necessary to graphitize the composite, which is not only time-saving but also a large energy saver. A new approach to the oxidation protection carbon-carbon composites is also possible due to the development of the In-Situ Densification Process. Since graphitization of the composite is not needed to enhance the mechanical properties of the composite, the temperature of the composite to never exceeds 1000°C. With this new process, the oxidation protection liner or shell is fabricated first as a free-standing part. Post-processing of this part is then performed, to maximize its mechanical and thermal properties. A carbon-fiber preform is then placed around or inside the liner or shell. The preform is then densified by the In-Situ Densification Process, producing a carbon-carbon composite with an integral oxidation-resistant component that does not spall or crack. To date ceramic and rhenium liners applied by this method have performed exceedingly well in both solid- and liquid-rocket nozzle environments.

Background

Carbon-carbon composites possess~~es~~ a unique set of properties that make them ideal materials for high temperature structural use. They are stronger and stiffer than steel, while less dense than aluminum. The composites maintain their mechanical properties to temperatures in excess of 3000°C, while the composite's material properties actually improve with heating as the non-ordered carbon is converted to the ordered graphite structure through the process of graphitization. The use of carbon-carbon composites has been limited because of the high cost and oxidation at elevated temperatures. Breaking through limitations, AFRL is offering new applications such as low-cost, lightweight composite rocket nozzles.

Additional information

To receive more information about this or other activities in Air Force Research Laboratory, contact the Technology Transfer Branch, AFRL/XPTT, 1-800-203-6451 and you will be directed to the appropriate Laboratory expert.